Appendix B

Reach-based Ecosystem Indicators (REI)

Upper Methow River Reach Assessment

December 2015

Contents

1 Introduction

1.1 BACKGROUND

The REI provides a consistent means of evaluating biological and physical conditions of a watershed in relation to regional standards and known habitat requirements for aquatic biota. These indicators, along with other scientific evaluations, describe the current quality of stream biophysical conditions and can help inform restoration targets and actions. The REI indicators used in this assessment are adaptations from previous efforts including the NMFS matrix of pathways and indicators (NMFS 1996) and the USFWS (1998). With a few exceptions, the REI are based on the USBR's latest adaptations and use of these indicators (USBR 2012).

The REI evaluation for the Upper Methow River was conducted using field data, observations, previous studies, and available data for the study area. In particular, the rankings were developed based on: 1) quantitative inventory information from the Habitat Assessment performed as part of the Reach Assessment using USFS (2010) protocols, 2) assessment of geomorphic patterns and processes and how they have deviated, if at all, from historical conditions, and 3) analysis of existing watershed assessments and data (e.g. available ArcMap layers and shapefiles). Functional ratings include **Adequate**, **At Risk**, or **Unacceptable**. The REI analysis helps to summarize habitat impairments and to distill the impairments down to a consistent value that can be compared among reaches.

1.2 SUMMARY OF RESULTS

Reaches below the confluence of Lost River with the upper Methow River (Reaches 1-6) were generally the most impacted reaches, having the highest number of **Unacceptable** ratings. Reaches 5 and 6, though having slightly fewer **Unacceptable** ratings, both had high numbers of **At Risk** ratings due to the amount of residential development along the banks of those reaches. Reach 7 had seven **At Risk** ratings, with only one **Unacceptable** rating. Reaches 8 and 9 were the least impacted, with Reach 9 receiving all **Adequate** ratings and Reach 8 having only one **At Risk** and **Unacceptable** rating each.

All reaches were given **Adequate** ratings for the Habitat Access Pathway- Main Channel Barriers indicator since there were no barriers within the main channel that completely excluded fish passage in any of the reaches. All reaches (except Reaches 8 and 9, which did not have substrate sampled) were also given an **Adequate** rating for the Dominant Substrate/Fine Sediment indicator due to gravel counts meeting appropriate percentages and minimal fine sediments in all reaches. LWM was rated **Adequate** only in Reach 9 and **At Risk** only in Reach 5, while all other reaches were given **Unacceptable** ratings due to low numbers of pieces of large and medium woody debris per mile and limited (or no) jams present in the reach. Canopy cover over the main channel was Unacceptable in Reaches 1 – 5 due to riparian clearing from residential and agricultural development. Reaches 6 and 7, though less developed, still only received **At Risk** rankings for canopy cover due to the legacy of timber harvests which has resulted in smaller, younger trees within the riparian zone. Bank Stability and Floodplain Connectivity indicators were similar, with Reaches 7, 8 and 9 receiving ratings of **Adequate** in both indicators. Reaches 3 and 5 were rated **At Risk**, and Reaches 1, 2, 4, and 6 were given **Unacceptable** ratings due to the number of human features and disturbances in those reaches.

For the study area as a whole, **Adequate** was the most common rating (38), followed by **Unacceptable** (31), then **At Risk** (30).

2 Metrics and Indicators

Pathway	General Indicators	Specific Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition
Watershed Scale					
Watershed Condition	Effective Drainage Network and Watershed Road Density	Increase in Drainage Network/Road Density	Zero or minimum increases in active channel length correlated with human caused disturbance. Road density <1 miles/miles^2.	Low to moderate increase in active channel length correlated with human caused disturbances. Road density 1-2.4 miles/miles^2.	Greater than moderate increase in active channel length correlated with human caused disturbances. Road density >2.4 miles/miles^2.
	Disturbance Regime	Natural/Human Caused	Environmental disturbance is short-lived; predictable hydrograph, high quality habitat and watershed complexity providing refuge and rearing space for all life stages or multiple life-history forms. Natural processes are stable.	Scour events, debris torrents, or catastrophic fires are localized events that occur in several minor parts of the watershed. Resiliency of habitat to recover from environmental disturbances is moderate.	Frequent flood or drought producing highly variable and unpredictable flows, scour events, debris torrents, or high probability of catastrophic fire exists throughout a major portion of the watershed. The channel is simplified, providing little hydraulic complexity in the form of pools or side channels. Natural processes are unstable.
Flow/Hydrology	Streamflow	Change in Peak/Base Flows	Magnitude, timing, duration, and frequency of peak flows within a watershed are not altered relative to natural conditions of an undisturbed watershed of similar size, geology, and geography.	Some evidence of altered magnitude, timing, duration and/or frequency of peak flows relative to natural conditions of an undisturbed watershed of similar size, geology, and geography.	Pronounced changes in magnitude, timing, duration and/or frequency of peak flows relative to natural conditions of an undisturbed watershed of similar size, geology, and geography.
Water Quality	Temperature	Daily maximum and 7-day mean maximum temperatures	Bull Trout: Incubation 2-5°C, rearing 4-10°C, spawning 1-9°C. Salmon and Steelhead: June-Sep t 15°C, Sept-May 12°C, rearing 15°C, migration 15°C, adult holding 15°C. OR 7-day daily maximum temperature performance standards: Salmon spawning 13°C, core summer salmonid habitat 16°C. Salmonid spawning, rearing and migration 17.5°C. Salmonid rearing and migration only 17.5°C.	MWMT in reach during the following life history stages: Incubation <2°C or <6°C; rearing <4°C or >13-15°C; spawning <4°C or >10°C. Temperatures in areas used by adults during the local spawning migration sometimes exceed 15°C. OR 7-day average daily maximum temperature standards are exceeded by ≤15%.	MWMT in reach during the following life history stages: Incubation <1°C or <6°C; rearing >15°C; spawning <4°C or >10°C. Temperatures in areas used by adults during the local spawning migration sometimes exceed 15°C. OR 7-day average daily maximum temperature standards are exceeded by ≤15%.
	Turbidity	Turbidity NTU's	Performance Standard: Acute <70 NTU, Chronic <50 NTU. For streams that naturally exceed these standards: Turbidity should not exceed natural baseline levels at the 95% CL <15% exceedance. OR Turbidity shall not exceed: 5 NTU over background when the background is 50 NTU or less; or a 10% increase in turbidity when the background turbidity is more than 50 NTU (WDOE 173-201A-200)	15-50% exceedance.	>50% exceedance.
	Chemical Contamination/ Nutrients	Metals/Pollutants, pH, DO, Nitrogen, Phosphorus	Low levels of chemical contamination from landuse sources, no excessive nutrients, no CWA 303d designated reaches. OR Washington State Department of Ecology standards 173-201A-200.	Moderate levels of chemical contamination from landuse sources, some excess nutrients, one CWA 303d designated reach.	High levels of chemical contamination from landuse sources, high levels of excess nutrients, more than one DWA 303d designated reach.

Pathway	General Indicators	Specific Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition
Reach Scale					
Habitat Access	Physical Barriers	Main Channel Barriers	No man-made barriers present in the mainstem that limit upstream or downstream migration at any flow.	Man-made barriers present in the mainstem that prevent upstream or downstream migration at some flows that are biologically significant.	Man-made barriers present in the mainstem that prevent upstream or downstream migration at multiple or all flows.
Habitat Quality	Substrate	Dominant Substrate/Fine Sediment	Gravels or small cobbles make up >50% of the bed materials in spawning areas. ≤12%fines/sand (<2 mm) in spawning gravel.	Gravels or small cobbles make up 30-50% of the bed materials in spawning areas. 12-17% fines (<2 mm) in spawning gravel.	Gravels or small cobbles make up <30% of the bed materials in spawning areas. >17% fines (<2 mm) in spawning gravel.
	LWM	Pieces per Mile at Bankfull	>42.5 pieces/mile >12" diameter and >35 ft long (based on data from Fox and Bolton 2007); adequate sources of woody debris available for both long- and short-term recruitment. And, at least 4 jams/mile based on Reaches 5 and 9 as reference reaches for jam quantities.	Current levels are able to maintain the minimum requirements for an "adequate" rating, but potential sources for long-term woody debris recruitment, as determined by the Riparian Structure reach metrics, are lacking in order to maintain these current levels.	Current levels are not meeting the minimum requirements for an "adequate" rating, and potential sources of woody debris for short- and/or long-term recruitment are lacking as well.
	Pools	Pool Frequency and Quality; presence of large pools.	Pool frequency: Number of pools/mile for a given channel width. Channel widths were highly variable throughout the Upper Methow River, therefore channel width metrics of 65-100 ft = 4 pools/mile or 40-65ft = 9 pools/mile will be used to determine adequate conditions based on average bankfull widths in each reach. Reaches with average bankfull widths greater than 100 ft will be assessed using the 4 pools/mile metric. Pools must also have good cover and cool water with only a minor reduction in pool volume from fine sediment. Each adequate reach has many large pools >1 m (3 ft) deep with good fish cover.	Pool frequency is similar to the values for the "adequate" rating, but pools have inadequate cover/temperature and/or there has been a moderate reduction of pool volume by fine sediment. Reaches have few large pools (>1 m deep) present with good fish cover.	Pool frequency is considerably lower than the values for the "adequate" rating. Pools also have inadequate cover/temperature and there has been a major reduction of pool volume by fine sediment. Reaches have no large pools (>1 m deep) with good fish cover.
	Off-Channel Habitat	Connectivity with Main Channel	Reach has many ponds, oxbows, backwaters, and other off-channel areas with cover. Side channels are low energy areas. No man-made barriers present along the mainstem that prevent access to off-channel areas.	Reach has some ponds, oxbows, backwaters, and other off-channel areas with cover. Side channels are high energy areas. Man-made barriers are present that prevent access of off-channel habitat at some flows that are biologically significant.	Reach has few or no ponds, oxbows, backwaters, and other off-channel areas. Man-made barriers are present that prevent access to off-channel habitat at multiple or all flows.
Channel	Dynamics	Floodplain Connectivity	Floodplain areas are hydrologically linked to main channel within the context of the local process domain; overbank flows occur and maintain wetland functions, and riparian vegetation and succession. Naturally confined channels are considered adequate.	Reduced linkage of wetland, floodplains and riparian areas to main channel in reaches with historically strong connectivity; overbank flows are reduced relative to historic frequency, as evidenced by moderate degradation of wetland function and riparian vegetation/succession.	Severe reduction in hydrologic connectivity between off-channel, wetland, floodplain, and riparian areas relative to historical connectivity; wetland extent drastically reduced and riparian vegetation/succession is altered significantly.

Pathway	General Indicators	Specific Indicators	Adequate Condition	At Risk Condition	Unacceptable Risk Condition
		Bank Stability/Channel Migration	Channel is migrating at or near natural rates.	Limited amount of channel migration is occurring at a faster/slower rate relative to natural rates, but significant change in channel width or planform is not detectable; large woody debris is still being recruited.	Little or no channel migration is occurring because of human actions preventing reworking of the floodplain and large woody debris recruitment; or channel migration is occurring at an accelerated rate such that channel width has at least doubled, possibly resulting in a channel planform change, and sediment supply has noticeably increased from bank erosion.
		Vertical Channel Stability	No measurable trend of aggradation or incision and no visible change in channel planform.	Measurable trend of aggradation of incision that has the potential to, but has not yet caused, disconnection of the floodplain or a visible change in channel planform (e.g. single thread to braided.)	Enough incision has occurred that the floodplain and off-channel habitat areas have been disconnected; or enough aggradation has occurred to create a visible change in channel planform (e.g. single thread to braided.)
Riparian Vegetation	Condition	Structure	>80% species composition, seral stage, and structural complexity are consistent with potential native community.	50-80% species composition, seral stage, and structural complexity are consistent with potential native community.	<50% species composition, seral stage, and structural complexity are consistent with potential native community.
		Disturbance (Human)	>80% mature trees (medium-large) in the riparian buffer zone (defined as a 30 m belt along each bank) that are available for recruitment by the river via channel migration; <20% disturbance in the floodplain (e.g. agriculture, residential, roads, etc.); <2 miles/miles^2 road density in the floodplain.	50-80% mature trees (medium-large) in the riparian buffer zone (defined as a 30 m belt along each bank) that are available for recruitment by the river via channel migration; 20-50% disturbance in the floodplain (e.g. agriculture, residential, roads, etc.); 2-3 miles/miles^2 road density in the floodplain.	<50% mature trees (medium-large) in the riparian buffer zone (defined as a 30 m belt along each bank) that are available for recruitment by the river via channel migration; >50% disturbance in the floodplain (e.g. agriculture, residential, roads, etc.); >3 miles/miles^2 road density in the floodplain.
		Canopy Cover	Trees and shrubs within one site potential tree height distance have >80% canopy cover that provides thermal shading to the river.	Trees and shrubs within one site potential tree height distance have 50-80% canopy cover that provides thermal shading to the river.	Trees and shrubs within one site potential tree height distance have <50% canopy cover that provides thermal shading to the river.

3 REI Ratings

This section discusses the results for each indicator, rated at either the reach-scale or watershed-scale for all six reaches.

3.1 WATERSHED-SCALE RATINGS

General Characteristics	General Indicators	Specific Indicators	Rating	Discussion
Watershed Scale				
Watershed Condition	Effective Drainage Network and Watershed Road Density	Increase in Drainage Network/Road Density	Adequate Condition	Road density was calculated using USFS roads and Okanogan County roads shapefiles. Road density was calculated for the watershed area contributing to the study area as determined in the Streamstats online mapper application (USGS 2014). Areas of overlap in the data sets were removed to eliminate over overestimation of road density. A large portion of the watershed has little to no roads, and should therefore be given an Adequate rating, while other portions of the watershed, such as within the more populated area along the river and within the town of Mazama, have many roads and would likely have At Risk or Unacceptable ratings. Average road density for the entire contributing watershed was 0.57 miles/mile^2, which puts the study area within the Adequate category.
	Disturbance Regime	Natural/Human Caused	At Risk Condition	This disturbance history rating reflects historical accounts of riparian and hillslope timber harvest, mining, grazing, agriculture and roads and residential development. These activities have been shown to create channel instability and decrease the ability of the system to respond to natural disturbance regimes such as fire or flood. The watershed has a naturally frequent fire regime, annual snowmelt flooding and infrequent rain-on-snow floods, and active tributary alluvial fans. The channel has reduced complexity and floodplain connection, and is shown to be incising in some areas and aggrading in others. Furthermore, fire suppression within the basin has elevated the risk of potential catastrophic disturbance (e.g. stand-replacing fire) to the study area. Currently nearly all the watershed is within federal ownership and large portions of it are protected areas. Therefore, the likelihood of continuing disturbance other than from natural causes is low. However, the alterations from past human disturbance are still affecting the River (such as the lag between riparian timber harvest and in-stream LWD removal that takes many years for new trees to mature and fall into the river). The system is still recovering from these “press” disturbances that have a persistent and long-lasting impact. Based on this information, the Upper Methow receives a rating of At Risk.
Flow/Hydrology	Streamflow	Change in Peak/Base Flows	At Risk Condition	The hydrology of the watershed contributing to the Upper Methow study area on the Methow River is driven by a combination of precipitation and snowmelt. Annual snowmelt flooding in the spring and early summer, with infrequent rain-on-snow floods dominates the season streamflow pattern in the basin. Snowmelt runoff is primarily driven by changes in ambient air temperature, snowpack mass, and the elevation distribution of the season's snowpack. Peak runoff usually occurs from April through July, with the highest rates typically in late June. The Methow River typically returns to baseflow by late August. Low instream flows (sections that go subsurface leaving the riverbed dry during the late summer and early fall months) have been designated as water quality limited and placed on the 303(d) list by the state. Many of the land-use activities and channel alterations affecting the Methow River have been shown to change one or all of the above-mentioned attributes of peak flows in other basins. Climate change models indicate that rainfall is expected to increase one to two percent by 2040, and four percent by 2080 (e.g. Mote and Salanthe 2009) and likely result in an increase in winter stream flows, earlier and lower peak runoff, and lower summer baseflows. These analyses suggest that human-induced climate change is likely to have an effect on the magnitude, timing, duration, and frequency of streamflows. Based on the effects of past watershed management, and the potential effects of climate change, this indicator is rated At Risk for the Upper Methow River.

Water Quality	Temperature	Daily maximum and 7-day mean daily maximum temperatures	Adequate Condition	Water quality in the upper Methow River is generally very good. It is classified as AA (extraordinary) by Washington Department of Ecology. Water temperatures in the lower portion of the study area can exceed the state water quality standards during the summer, while ice development in the winter has been recognized as a potential problem for juvenile salmonids in the mainstem Methow River.
	Turbidity	Turbidity NTU's	N/A	Data was unavailable.
	Chemical Contamination/ Nutrients	Metals/Pollutants, pH, DO, Nitrogen, Phosphorus	N/A	Data was unavailable.

3.2 REACH-SCALE RATINGS

Pathway	General Indicators	Specific Indicators	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9
Habitat Access	Physical Barriers	Main Channel Barriers	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate
			There are no anthropogenic barriers in the main channel in Reach 1.	There are no anthropogenic barriers in the main channel in Reach 2.	There are no anthropogenic barriers in the main channel in Reach 3.	There are no anthropogenic barriers in the main channel in Reach 4.	There are no anthropogenic barriers in the main channel in Reach 5.	There are no anthropogenic barriers in the main channel in Reach 6.	There are no anthropogenic barriers in the main channel in Reach 7.	There are no anthropogenic barriers in the main channel in Reach 8.	There are no anthropogenic barriers in the main channel in Reach 9.
Habitat Quality	Substrate	Dominant Substrate / Fine Sediment	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate	Adequate
			One pebble count: Gravel: 46% Cobble: 52% Sand: 2%	Two pebble counts: Gravel: 48% & 50% Cobble: 52% & 50% Sand: 0% & 1%	Two pebble counts: Gravel: 65% & 36% Cobble: 35% & 61% Sand: 0% & 1% Boulder: 2%	One pebble count: Gravel: 29% Cobble: 66% Sand: 0% Boulder: 5%	Three pebble counts: Gravel: 48% & 66% & 67% Cobble: 40% & 31% & 28% Sand = 9% & 2% & 5% Boulder: 3% & 1% & 0%	Two pebble counts: Gravel: 40% & 50% Cobble: 56% & 45% Sand: 1% & 3% Boulder: 3% & 2%	Two pebble counts: Gravel: 32% & 51% Cobble: 56% & 46% Sand: 5% & 0% Boulder: 6% & 4%	N/A	N/A
	LWM	Pieces per Mile at Bankfull	Unacceptable	Unacceptable	Unacceptable	Unacceptable	At Risk	Unacceptable	Unacceptable	Unacceptable	Adequate
			M+L pieces/mi = 2.5 Jams/mi = 0 Minimal availability of large wood for future recruitment.	M+L pieces/mi = 64.3 Jams/mi = 2.9 Moderate availability of large wood for future recruitment.	M+L pieces/mi = 76.3 Jams/mi = 3.1 Moderate availability of large wood for future recruitment.	M+L pieces/mi = 23.2 Jams/mi = 0.7 Limited availability of large wood for future recruitment.	M+L pieces/mi = 62.5 Jams/mi = 4.4 Moderate availability of large wood for future recruitment.	M+L pieces/mi = 48.3 Jams/mi 2.8 Moderate availability of large wood for future recruitment.	M+L pieces/mi = 68.4 Jams/mi = 3.8 Moderate-to-high availability of large wood for future recruitment.	M+L pieces/mi = 57.5 Jams/mi = 1.8 Moderate-to-high availability of large wood for future recruitment.	M+L pieces/mi = 110.2 Jams/mi = 4.5 Moderate availability of large wood for future recruitment.
	Pools	Pool Frequen-cy and Quality; presence of large pools.	Unacceptable	At Risk	At Risk	Unacceptable	Adequate	Adequate	At Risk	At Risk	Adequate
			Total Pools = 0 Pools/mi = 0 Pools > 3 ft = 0	Total Pools = 4 Pools/mi = 1.25 Pools > 3 ft = 3 Average residual pool depth: 5.4 ft Moderate pool shading and cover	Total Pools = 7 Pools/mi = 5.5 Pools > 3 ft = 7 Average residual pool depth: 5.8 ft Moderate pool shading and cover	Total Pools = 5 Pools/mi = 1.7 Pools > 3 ft = 5 Average residual pool depth: 4.9 ft Minimal pool shading and cover	Total Pools = 11 Pools/mi = 5.3 Pools > 3 ft = 9 Average residual pool depth: 4.5 ft Moderate pool shading and cover	Total Pools = 23 Pools/mi = 6.3 Pools > 3 ft = 14 Average residual pool depth: 4.2 ft Moderate pool shading and cover	Total Pools = 13 Pools/mi = 7.5 Pools > 3 ft = 7 Average residual pool depth: 3.4 ft Moderate pool shading and cover	Total Pools = 3 Pools/mi = 1.4 Pools > 3 ft = 2 Average residual pool depth: 4.7 ft Moderate pool shading and cover	Total Pools = 4 Pools/mi = 3 Pools > 3 ft = 3 Average residual pool depth: 4.1 ft Moderate pool shading and cover. This reach would not historically be expected to have many pools, therefore is Adequate.

Pathway	General Indicators	Specific Indicators	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9
	Off-Channel Habitat	Connect-ivity with Main Channel	Unacceptable Total SC = 0 Fast water = 0 Slow water = 0 Cover = limited Is a naturally moderately confined channel, therefore would expect to have some, but not substantially greater amounts off-channel habitat.	Unacceptable Total SC = 9 Fast water = 4 Slow water = 5 Cover = limited Would expect to see more off-channel habitats in this reach. Artificial levees are blocking portions of floodplain and reducing connectivity.	Unacceptable Total SC = 4 Fast water = 3 Slow water = 1 Cover = limited Would expect to see more off-channel habitats in this reach. Artificial levees are blocking portions of floodplain and reducing connectivity.	At Risk Total SC = 4 Fast water = 2 Slow water =2 Cover = limited Would expect to have some, but not substantially greater amounts off-channel habitat due to natural moderate confinement.	Adequate Total SC = 7 Fast water = 0 Slow water = 7 Cover = moderate-adequate Would expect to have greater amounts off-channel habitat. Artificial levees are blocking portions of the floodplain at the upstream end of this reach.	At Risk Total SC = 8 Fast water = 1 Slow water = 7 Cover = moderate Naturally unconfined channel. Historically more side channels would be expected in this reach. Residential building has disconnected floodplain and secondary channel features.	At Risk Total SC = 7 Fast water = 5 Slow water = 2 Cover = moderate Historically more side channels, especially slow-moving channels, would be expected in this reach. Residential building has disconnected the floodplain and secondary channel features.	Adequate Total SC = 4 Fast water = 2 Slow water = 2 Cover = moderate-adequate Naturally confined channel in some locations. Few human alterations in this reach. Channel is adequately meeting its off-channel habitat potential.	Adequate Total SC = 4 Fast water = 2 Slow water = 2 Cover = moderate-adequate Naturally confined channel. Few human alterations in this reach. Channel is adequately meeting its off-channel habitat potential.
Riparian Vegetat-ion	Condition	Structure	Unacceptable 100% small tree Seral stage - should see more patches of mature trees Species composition is lacking- only Cottonwood was observed Structural complexity is unacceptable, historically more mature trees would have been present.	Unacceptable 100% small tree Seral stage - should see more patches of mature trees Species composition is adequate- Dogwood, Cottonwood, and willow were observed. Structural complexity is unacceptable, historically more mature trees would have been present.	At Risk 75% small tree 25% grass/forb Seral stage - should see more patches of mature trees. Species composition is at risk. Ponderosa pine was observed as the primary overstory within the riparian area, indicating hydrological changes. Cottonwood was observed in both the overstory and understory, as well as grassland/forbs in the understory.	Unacceptable 100% small tree Seral stage - should see more patches of mature trees. Species composition is at risk, due to the riparian zone being primarily Ponderosa Pine with some Western Red Cedar. Understory species such as dogwood were observed.	At Risk 67% small tree 33% sapling/pole Seral stage - should see more patches of mature trees. Species composition is adequate- the overstory was entirely cottonwood which the understory consisted of snowberry, mountain maple, dogwood, and various grasses/forbs.	At Risk 78% small tree 11% sapling/pole 11% large tree Seral stage – Though there are patches of larger trees in the riparian area, historically there would have been greater amounts of mature Cottonwoods, Douglas Fir, and Ponderosa Pine, which would contribute to a healthier structural complexity. Species composition is at risk.	At Risk 40% small tree 20% sapling/pole 40% shrub/seedling Seral stage – The riparian zone is relatively young. Historically there would have been patches of larger, mature trees in this reach. Species composition is at risk, with overstory vegetation being primarily cottonwood and some large dogwood, while understory was snowberry,	At Risk 100% small tree Seral stage – should include more patches of mature trees. The legacy of timber harvest has affected age classes in the riparian zone. Species composition is adequate, with Douglas fir and Western Red Cedar being primary overstory vegetation, while snowberry, mountain maple, and dogwood were the main understory species.	Adequate 100% small tree Seral stage and species composition – though there should be more mature trees in this reach, the recent fire and avalanche (natural disturbances) have affected the seral stages present in this reach. The species composition of a Douglas fir overstory and manzanita/dogwood understory was also affected by the fire. This reach is still given an adequate ranking despite not

Pathway	General Indicators	Specific Indicators	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9
					Structural complexity is unacceptable.				mountain maple, dogwood and grasses/forbs.		meeting the criteria, largely because the fire and avalanche are natural regimes that occur on the landscape.
		Disturb-ance (Human)	At Risk Disturbed low surfaces = 3.04% Road Density = 1.07 miles/miles2 Minimal-moderate amounts of medium-large trees within the riparian buffer available for recruitment of the river via channel migration. Much smaller and fewer patches than historically would be expected.	At Risk Disturbed low surfaces = 26.13% Road Density = 2.75 miles/miles2 Minimal medium-large trees in the riparian buffer available, except in a couple locations between RMs 63-64, for recruitment of the river via channel migration. Much smaller and fewer patches than historically would be expected.	Unacceptable Disturbed low surfaces = 44.65% Road Density = 2.56 miles/miles2 Almost no medium-large trees in the riparian buffer are available for recruitment of the river via channel migration. Historically much larger trees would have been present.	Unacceptable Disturbed low surfaces = 23.89% Road Density = 0.33 miles/miles2 Minimal amounts of medium-large trees in the riparian buffer available for recruitment of the river via channel migration. Historically much larger trees would have been present.	At Risk Disturbed low surfaces = 33.32% Road Density = 3.86 miles/miles2 Minimal-moderate amounts of medium trees in the riparian buffer available for recruitment of the river via channel migration. Historically much larger trees would have been present.	Unacceptable Disturbed low surfaces = 27.10% Road Density = 4.02 miles/miles2 Moderate amounts of medium-large trees in the riparian buffer are available for recruitment in the middle of this reach, although residential uses along the river have minimized much of the larger and more mature trees that would have been present historically.	At Risk Disturbed low surfaces = 18.38% Road Density = 0.95 miles/miles2 Minimal amounts of medium-large trees in the riparian buffer available for recruitment of the river via channel migration. Historically much larger trees would have been present.	At Risk Disturbed low surfaces = 4.18% Road Density = 1.32 miles/miles2 Minimal amounts of medium-large trees in the riparian buffer are available for recruitment. Historically much larger trees would have been present. The natural fire disturbance can be attributed to some of this, therefore this reach is only given an At Risk rating.	Adequate Disturbed low surfaces = 0% Road Density = 0 miles/miles2 Moderate amounts of medium-large trees in the riparian buffer are available for recruitment. Historically much larger trees would have been present. The natural fire and avalanche disturbances can be attributed to some of this, therefore this reach is given an Adequate rating.
		Canopy Cover	Unacceptable Canopy Cover = 15% Portions of the main channel and a majority of the off-channel habitat have more thermal shading	Unacceptable Canopy Cover = 20% Large trees on river right between RMs 62.75and 63.25 provide moderate canopy cover and	Unacceptable Canopy Cover = 20% The trees atop a steep bank along river right contribute to increased thermal shading. However,	Unacceptable Canopy Cover = 10% A large portion of the river banks are cleared and graded, providing no thermal shading. Very few	Unacceptable Canopy Cover = 20% Portions of the river banks are cleared and graded, providing minimal to no thermal shading	At Risk Canopy Cover = 30% Portions of the main channel have no canopy cover or shading, while other sections (where there are	At Risk Canopy Cover = 25% Channel width decreases in this reach that is above the confluence with Lost River. There	Adequate Canopy Cover = 90% The channel is much smaller and more naturally confined with steep river bank walls in this reach	Adequate Canopy Cover = 60% There are fewer cleared areas along the banks due to residential or agricultural purposes, though

Pathway	General Indicators	Specific Indicators	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9
			from canopy cover. Stream and banks highly visible at several portions of the reach. Other residential or agricultural clearing and the relatively young seral stage of riparian vegetation results in minimal thermal shading of the reach. Goat Creek Cut-off adjacent to the channel on river left near RM 61.7 provides no shading to that portion of the stream.	thermal shading. However, the stream channel and banks are highly visible at several portions of the reach. Other residential or agricultural clearing and the relatively young seral stage of riparian vegetation results in minimal thermal shading of the reach.	the road adjacent to the river along most of this reach limits canopy cover potential. River left has been thinned and cleared limiting shading of the channel. Stream and banks are highly visible along a majority of the reach.	large trees line the river where there is forest still left. Other residential or agricultural clearing and the relatively young seral stage of riparian vegetation results in minimal thermal shading of the reach.	on the river channel. Very few large trees line the river banks where they have not been cleared. This relatively young seral stage of riparian trees provides little thermal shading from canopy cover over the main channel of the reach. Secondary channels have somewhat more shading and cover.	taller trees in the riparian areas) such as near RM 72.8 or RM 73.5, have up to 50% canopy cover. Secondary channels have somewhat more shading and cover throughout the reach also. Some residential or agricultural clearing along the banks contributes to the low canopy cover and shading of the main channel.	are fewer cleared areas along the banks due to residential or agricultural purposes, though the legacy of timber harvests along the riparian area has resulted in smaller, younger trees providing less shade and cover along the main channel than would have been found historically. Secondary channels are more shaded and have higher canopy cover percentages than the main channel.	than downstream, resulting in more natural shading and cover. There are no cleared areas along the banks due to residential or agricultural purposes, though the legacy of timber harvests along the riparian area has resulted in somewhat smaller, younger trees providing less shade and cover along the main channel than would have been found historically. Secondary channels are more shaded and have higher canopy cover percentages than the main channel.	the legacy of timber harvests along the riparian area has resulted in smaller, younger trees providing less shade and cover along the main channel than would have been found historically. Additionally, the natural disturbances of fire and avalanche has resulted in temporarily lower canopy cover and thermal shading. This reach still receives a rating of Adequate, due to the natural causes of the reduced cover and shading. Secondary channels also are more shaded and have higher canopy cover percentages than the main channel.
Channel	Dynamics	Flood-plain Connect-ivity	Unacceptable	Unacceptable	At Risk	Unacceptable	At Risk	Unacceptable	Adequate	Adequate	Adequate
			The Weeman Bridge and its associated approach fill at the downstream end of the reach interrupts floodplain flow paths and concentrates flow into the channel. Other areas of bank armoring and levees also affect	This reach is naturally unconfined and has a large floodplain. In addition to the high road density in the floodplain, the residential and agricultural features along the banks of the channel have restricted substantial natural	The road adjacent to the channel on river right for a majority of the reach restricts any potential floodplain activity. Levees and riprap have been used throughout the reach to prevent floodplain activation into agricultural and residential areas,	The bridge and associated bank armoring at RM 67.2 near Mazama reduces connectivity with the floodplain by interrupting floodplain flow paths and concentrating flow in the channel. Occasional other push up levees,	There are several riprap or levee features in this reach, though they do not disconnect the floodplain very substantially. They occur near the upstream end of the reach primarily. Road embankments along the river channel and	There is significant riprap and levees along the channel in this reach. Additionally, a large number of roads are present in the floodplain that restrict floodplain activation throughout the reach, primarily on river left. Due to	This reach is has few instances of human features in the floodplain that could restrict connectivity with the channel. Therefore, this reach is given an Adequate rating.	This reach is naturally laterally constricted by terraces and hillslopes on both sides of the channel and has little natural floodplain throughout the entire reach.	This reach is naturally laterally constricted by terraces and hillslopes on both sides of the channel and has little natural floodplain throughout the entire reach.

Pathway	General Indicators	Specific Indicators	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9
			floodplain connectivity.	floodplain activity, particularly on the river right floodplain where high-value habitat is present, resulting in an Unacceptable rating.	particularly on river left. Due to a relatively high road density in the floodplain, this reach is given an At Risk rating.	armored banks, and the floodplain gravel pit in the river-left floodplain at the downstream end of the reach all affect floodplain inundation rates and patterns.	secondary channels also disconnect the floodplain from the channel on river left. Due to these features, the channel is disconnected along portions of this reach, giving it an At Risk rating.	the high density of human features, the channel is substantially cut off from the floodplain and is therefore given an Unacceptable rating.			
		Bank Stability/ Channel Migration	Unacceptable	Unacceptable	At Risk	Unacceptable	At Risk	Unacceptable	Adequate	Adequate	Adequate
			This reach has some natural lateral constriction but occasional riprap and the Weeman Bridge constriction affect bank condition and channel migration processes significantly in these areas.	Between RM 62.5 and RM 63.25 the channel is naturally active and has recently avulsed resulting in the main channel straightening and a side channel/oxbow located in the historic main channel. RM 63.8 upstream to the end of the reach is naturally active and migrates frequently. The residential and agricultural features along the banks of the channel have restricted substantial natural migration activity, particularly on the river right floodplain where high-value habitat is present, resulting in an Unacceptable rating.	The road adjacent to the channel on river right for a majority of the reach restricts any potential migration activity. Levees and riprap have been used throughout the reach to prevent channel migration into agricultural and residential areas, particularly on river left where historical channel migration activity occurred.	The bridge at RM 67.2 near Mazama constrains lateral channel migration. Houses, roads, and other development along the banks also serve to impact bank conditions and channel migration rates. This reach is therefore given an Unaccptable rating.	There are a few instances of riprap or levees protecting houses and private property in this reach. These occur near the upstream end of the reach, between RM 70.75-71.25 primarily. Road embankments along the river channel and secondary channels also limit migration near RM 70 on river right and near RMs 71 and 71.25 on river left. Due to these human features, the channel is migrating below natural rates for this reach and is therefore given an At Risk rating.	There are a number of instances of riprap or levees protecting houses and private property in this reach. Additionally, roads built in the floodplain contribute to restricted migration of the channel throughout the reach, primarily on river left. Due to these human features, the channel is migrating significantly below natural rates for this reach and is therefore given an Unacceptable rating.	This reach is moderately unconfined, and there are few instances of human features in the floodplain that could restrict channel migration activity. Therefore, this reach is given an Adequate rating.	This reach is naturally laterally constricted by terraces and hillslopes on both sides of the channel throughout the entire reach. Historic channel location has not moved considerably, therefore the rate of channel migration has not changed substantially.	This reach is naturally laterally constricted by terraces and hillslopes on both sides of the channel throughout the entire reach. Historic channel location has not moved significantly.

Pathway	General Indicators	Specific Indicators	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8	Reach 9
			At Risk	At Risk	At Risk	At Risk	At Risk	At Risk	Adequate	Adequate	Adequate
		Vertical Channel Stability	Subtle channel bed incision and reduced floodplain connectivity due to channel confinement by riprap, bridge abutments, and levees. Modern alluvial terrace development at the downstream section of the reach.	Reduced channel sinuosity with a high potential for incision and reduced floodplain connectivity due to channel confinement by dikes, riprap, and levees.	Channel bed incision and reduced floodplain connectivity due to channel confinement by levees and riprap. High potential for continued incision processes in this reach.	Subtle channel bed incision resulting in reduced active floodplain connectivity, and alluvial terrace development.	Subtle channel bed incision resulting in reduced active floodplain connectivity, and alluvial terrace development.	Reduced channel sinuosity with some potential for incision and reduced floodplain connectivity due to channel confinement by riprap, and levees.	No measurable trend of aggradation or incision and no visible change in channel planform.	No measurable trend of aggradation or incision and no visible change in channel planform.	No measurable trend of aggradation or incision and no visible change in channel planform.

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